THONGCHAI SUWONSICHON[1]

TEXTURAL ASSESSMENT OF THAI RICE NOODLES

Summary

Mechanical tensile and fracture test were used in this study for assessing textural properties of five Thai rice noodles having the different levels of substituted tapioca flour (0%, 10%, 20%, 30% and 40% of composite rice flour and tapioca flour). Before testing tensile measurement, all specimens were shaped like dumbbell. The results showed that the maximum force, the extension and the total work significantly decreased from 0.55 to 0.43 N, 82.3 to 59.4 mm, and 0.030 to 0.017 J, respectively, when rice noodles contained tapioca flour 0% up to 40%. For fracture measurement, a single-edge-notched test, the results showed a similar pattern to tensile test. Adding the tapioca flour up to 40% decreased the maximum force, the extension and the total work from 0.8 to 0.6 N, 54.1 to 32.2 mm and 0.042 to 0.025 J, respectively. When correlated with sensory hardness, the maximum tensile force and maximum fracture force, respectively, gave a good correlation of 0.77 ($p < 0.05$) and 0.90 ($p < 0.05$). The relationship between maximum force and sensory hardness can be explained by the quadratic polynomial equation having an R^2 greater than 0.9.

Introduction

Rice noodle was originated in China over two thousand years ago. It is one of popular staple foods in China, Japan and some countries in South East Asia. It is called Mi *fen* in Chinese, *Harusame* in Japanese *and Bihon* in Filipino [1, 2]. In Thailand, it is called *Kwoy Tuel* and is relatively simple to prepare. It is always available in restaurant, supermarket, at roadside stalls, from street vendors or at home. It is served with the addition of meatballs, fish ball, pork-chop, seafood, fish or soy sauce as well as vegetable such as bean-sprout and cabbage. Nowadays, there are many types of noodles offering for consumers not only a choice of shape, sizes but also a variety of mixed ingredients between rice flour with others. The process of making rice noodle varies form the conventional method, being limited to sun drying for small industry, to advanced technology, automatic machines producing fresh rice noodle.

[1]*Dept. of Product Development, Faculty of Agro-Industry, Kasetsart University, 50 Phahonyothin Road, Jatujak, Bangkok, Thailand, 10900*

Quality of rice flour or starch is one of major factors of rice noodle production. The rice noodle products can be varied from hard texture and easy fragile to quite soft, elastic and sticky after cooking with hot water or soups. They depend on rice varieties and their amylose contents. Occasionally, the industries may lack of raw material or would like to reformulate rice noodle to have a better texture or would like to reduce their cost of production. For their reformulation and new product development, manufactures may add other flours like root crop flours such as cassava, potato or arrowroot to get highly attractive in sensory quality such as the specific soft texture, good aroma and taste. Since there is no standard or recommended method for Thai rice noodle industries to assess their rice noodle products, they mostly use their experience to judge their quality. According to this, they will not get much information from their traditional technique for product development and quality control, especially, the cause of textural changes.

The objective of this work was to evaluate the methods of textural measurement as a tool for Thai rice noodle industries to assess the textural quality of their rice noodles.

Materials and methods

Preparation of Rice noodles

Rice flour and various tapioca flour levels of substitution (0%, 10%, 20%, 30% and 40% of composite rice starch and tapioca flour) were mixed together before making five rice noodles (five treatments). The process of rice noodle production for this experiment was shown in Figure 1. All rice noodles of each experiment were cooled down at room temperature (about 28–30°C) for 1 h before testing.

Tensile Test

All of five Thai rice noodles were shaped like dumbbell. Using Texture Analyzer TA 500 of LLOYD Instrument Ltd., England, performed tensile test of each noodle. Before testing, both ends of Rice noodle were sealed with sticky cloth tape and gripped with TG 33, Lightweight grip produced from LLOYD Instrument. All tests were performed at a constant crosshead speed 3 mm/s until noodle was broken down. To obtain the maximum tensile force (Newton: N), the extension (mm) before breaking, the total work (J) and the stiffness (gradient of the initial linear region of the graph), the raw data were imported to and processed by using Nexygen ® software version 3.0. Each rice noodle was performed in eighteen replicates.

Rice starch ↘ Tapioca flour (0%, 10%, 20%, 30% and 40% substitution) ↙

Mixed

↓

Added 35% w/w of water

↓

Stirred every 5 min for 30 min

↓

Poured 45 ml starch slurry into hot tray having size 20 x 30 cm^2

↓

Steamed for 3 min

↓

Cooled down for 15 min

↓

Spreaded oil 0.03 ml over starch film

↓

Taken it out of tray and cooled down before cutting and shaping

Fig. 1. Flow diagram of rice noodle process

Fracture test

Each rice noodle was cut into rectangles. At the center of noodle, one side was single edge notched about 1 mm before gripping. The condition of fracture testing and data processing were performed as well as tensile testing.

Sensory analysis

Panel of eleven students evaluated hardness and springiness. They are all senior students from Department of product development, Kasetsart University, Thailand. They were selected from 30 students and intensively trained every three days for a month about the definitions of those textural attributes of rice noodles as follows:

- Hardness is the force to pull a rice noodle apart by hands,
- Springiness is the degree to which a rice noodle returns to its original shape once it has been pull away between right and left hands.

After training, they evaluated five rice noodles from this experiment by using Magnitude of estimation, ratio-scaling [3]. Commercial rice noodles, bought from the market, were always served in the first sample and were rated as 100. Consequently, other five noodles were randomly served and were rated in relation to the first commercial rice noodle. For example, if the subsequent sample was half as hard as the first sample, the panel should assign it the value of 50. All data form magnitude estimation were transformed to logarithms before carrying out the analysis of variance (ANOVA).

Statistical analysis

Five rice noodle data from tensile test, fracture test and sensory test were subjected to SPSS version ® 9.05 for analysis of variance, the Pearson correlation and non linear regression. A significance level of $p < 0.05$ were used throughout this study.

Results and discussion

The Characteristic of Tensile force-extension and Fracture force-extension relationships of different five rice noodles

Typical tensile force and extension relationships as well as fracture test of five rice noodles having various percentage tapioca flour levels of substitution were shown in Figure 2 and 3, respectively. Additionally, the results of mechanically tensile tests and fracture tests are listed in Table 1 and 2, respectively.

Table 1

Tensile attribute means[1] and their standard deviations of five Thai rice noodles having different percentage tapioca flour levels of substitution.

Tensile attributes	% tapioca flour				
	0	10	20	30	40
Maximum force(N)	0.55 ± 0.078 a	0.57 ± 0.049 a	0.59 ± 0.119 a	0.50 ± 0.062 b	0.43 ± 0.094 c
Extension (mm)	82.8 ± 23.8 a	84.5± 19.32 a	91.0 ± 15.4 a	85.1 ± 13.9 a	59.4 ± 21.4 b
Total work (J)	0.030 ± 0.012a	0.033 ± 0.010a	0.0037±0.008a	0.031 ± 0.007a	0.017 ± 0.008b
Stiffness (-)	0.019 ± 0.01 a	0.017± 0.01 a	0.017± 0.01 a	0.018 ± 0.01 a	0.015±0.01 a

Note:[1] Means values are calculated from eighteen replicates samples.
a-c Means within the same row followed by the different letters are significantly different ($p < 0.05$).

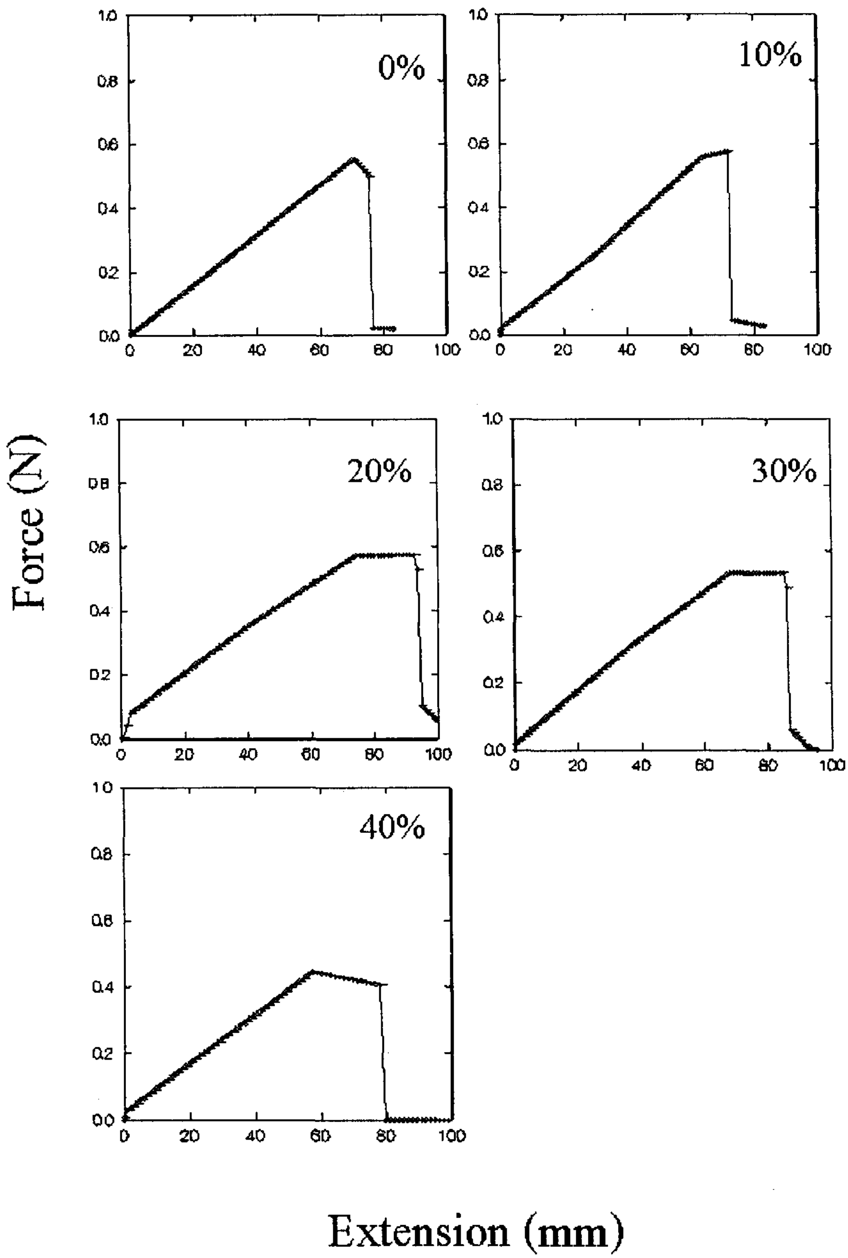

Fig. 2. Typical tensile force-extension of five rice noodles having different percentage tapioca flour levels of substitution.

From Figure 2 and 3, they show that rice noodle without addition of tapioca flour provides a hard texture because it has the highest maximum force. However, it is easy fragile because the force is suddenly droping into the origin after reaching the maximum force value. Conversely, rice noodle having 40% tapioca flour providing a soft and sticky texture shows the lowest maximum force and is quite ductile and does not suddenly ruptured after getting the maximum force. Moreover, table 1 and 2 also show that additional tapioca flour into rice noodle up to 20% will not provide any statistical significant different ($p > 0.05$) in the maximum force, the extension, the total work and the stiffness of tensile test and fracture test. From these results, it is quite clear that starch paste has an influence on texture of rice noodle product. Rice starch [4], and

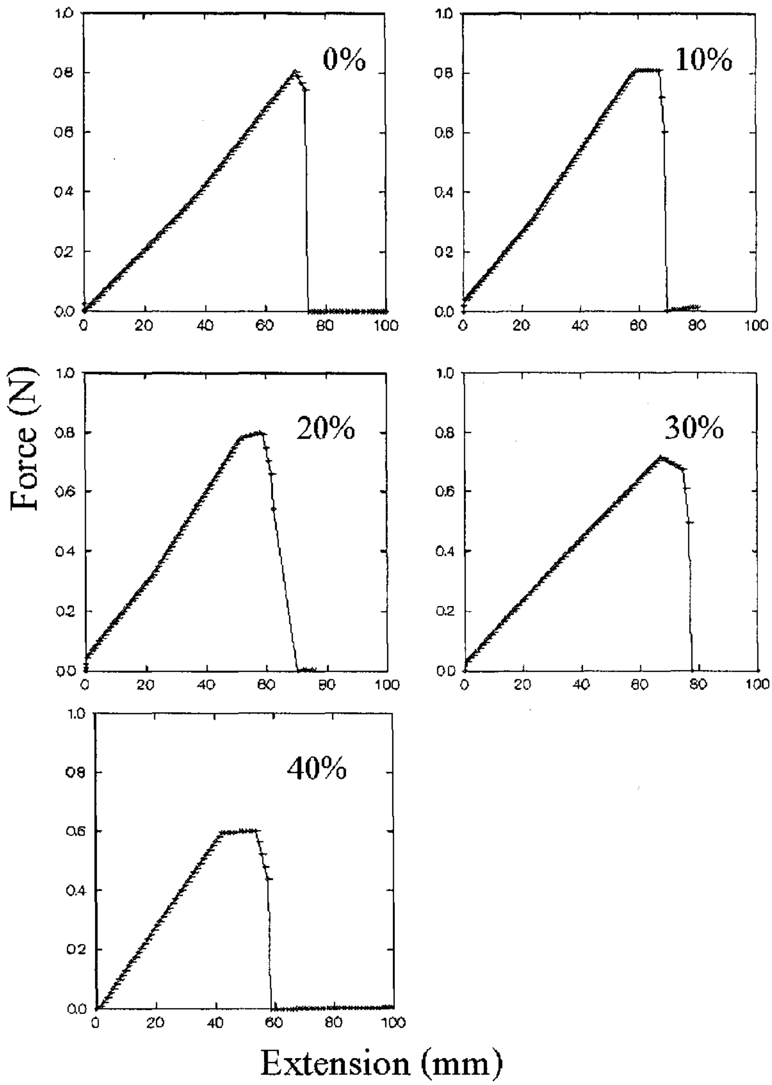

Fig. 3. Typical fracture force-extension of five rice noodles having different percentage tapioca flour levels of substitution.

cereal starch form viscous short bodied pastes and set to opaque gel on cooling. While tapioca starch, root and tuber starch, form highly viscous long bodied pastes, being clear and forming only a weak gel on cooling. In this study, tensile test shows a very good assessment to follow up the effect of starch paste mixture on the rice noodle quality. Rice noodle containing higher-level tapioca flour changes its texture from hard to soft gel and it is also quite sticky, not suddenly rupture.

Table 2

Fracture attribute means [1] and their standard deviations of five Thai rice noodles having different percentage tapioca flour levels of substitution.

Fracture attributes	% tapioca flour				
	0	10	20	30	40
Maximum force(N)	0.80 $\pm$ 0.18 a	0.78 $\pm$ 0.10 a	0.80 $\pm$ 0.06 a	0.62 $\pm$ 0.06 b	0.60 $\pm$ 0.09 c
Extension (mm)	54.14 $\pm$ 18.3 a	42.7$\pm$ 10.3 a	42.2 $\pm$ 16.7 a	38.8 $\pm$ 12.2 a	32.2 $\pm$ 14.3 b
Total work (J)	0.042 $\pm$ 0.019 a	0.035 $\pm$ 0.019 a	0.037 $\pm$ 0.018 a	0.031 $\pm$ 0.008 a	0.025 $\pm$ 0.011 b
Stiffness (-)	0.021 $\pm$ 0.01 a	0.011$\pm$ 0.006 a	0.011$\pm$ 0.005 a	0.017 $\pm$ 0.01 a	0.017$\pm$ 0.01 a

Note:[1] Means values are calculated from eighteen replicates samples.
a-c Means within the same row followed by the different letters are significantly different ($p<0.05$).

Sensory qualities

The panel responses to five rice noodles are presented in Table 3.

Table 3

Magnitude estimation as logarithmic means[1] and their standard deviations of five Thai rice noodles having different percentage tapioca levels of substitution.

Sensory attributes	% tapioca flour				
	0	10	20	30	40
Hardness	4.98 $\pm$ 0.13 a	4.78 $\pm$ 0.10 ab	4.77 $\pm$ 0.2 ab	4.6 $\pm$ 0.06 b	4.5 $\pm$ 0.68 b
Springiness	4.93 $\pm$ 0.25 a	4.66$\pm$ 0.4 a	4.62 $\pm$ 0.46 a	4.71 $\pm$ 0.39 a	4.62 $\pm$ 0.65 a

Note:[1] Means values are calculated from eighteen replicates samples
a-c Means within the same row followed by the different letters are significantly different ($p < 0.05$).

Table 3 shows that hardness of rice noodles is significantly lessen ($p < 0.05$) as the increment of substituted tapioca flour. None the less, panelists cannot detect any significant difference in springiness. The results of sensory assessment follow a similar pattern in mechanical testing as described in previous section. There is a significant correlation between maximum force of tensile test or fracture test and sensory hardness as presented in Table 4. These relationships can be predicted by using a nonlinear regression model, the quadratic polynomial equation, having an R^2 greater than 0.9 as shown in Figure 5 and 6.

Table 4

Pearson's correlation coefficients ($p<0.005$) between mechanical and sensory attributes.

Attributes	Maximum Tensile force	Maximum Fracture force	Hardness
Maximum Tensile force	1	0.918	0.765
Maximum Fracture force	0.918	1	0.896
Hardness	0.765	0.896	1

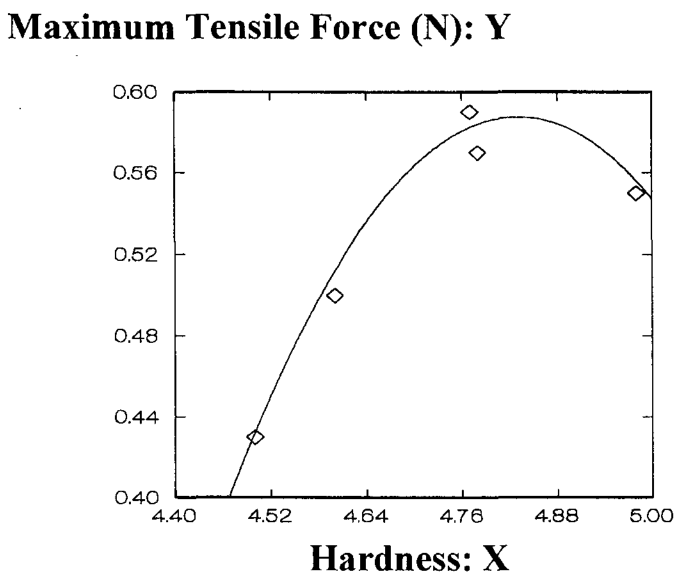

Fig. 5. Relationship between sensory hardness evaluated by Magnitude estimation and maximum tensile force. The solid line is the fit curve of nonlinear equation : $Y = -32.528+13.71*x-1.419*x^2$, $R^2 = 0.98$.

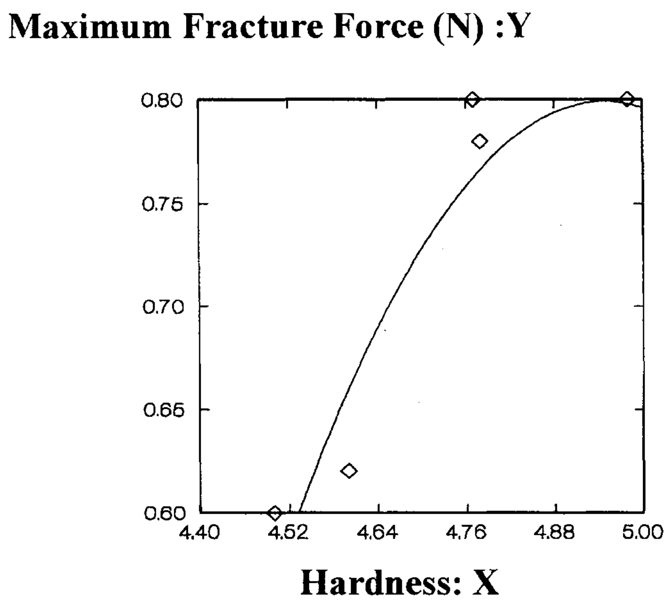

Fig. 6. Relationship between sensory hardness evaluated by Magnitude estimation and maximum fracture force. The solid line is the fit curve of nonlinear equation: $Y = -27.384+11.391*x-1.151*x^2$, $R^2 = 0.91$.

Conclusion

Tensile test and Fracture test are very applicable to assess the textural quality of Thai rice noodles. Form this study, those two methods not only can followed up the effect of substituted tapioca flour in rice noodles but also have a highly correlation with sensory evaluation using ratio scale, Magnitude estimation. The relationship between mechanical test, maximum force, and sensory test, hardness, in this study can be predicted by using non-linear regress providing an R^2 greater than 0.9.

Acknowledgment

The authors gratefully acknowledge Assoc. Prof. Vichai Haruthiathanasan, the director of Kasetsart Agricultural and Agro-Industrial Product Improvement Institue (KAPI), Kasetsart University, Thailand and Assoc. Prof. Klanarong Sriroth, Head of Cassava and Strach Technology Research Unit, KAPI for all of their suggestion and support of this project.

References

[1] Collado L.S., Mabesa L.B., Oates, C.G., Corke H.: J. Food Sci., 2001, **66(4)**, 604-609.
[2] Luh B.S.: in Asian Foods Science & Technology, p 19, ed by C.Y.W. Ang., K. Liu. and Y. Huang. Technomic Publishing Lanscaster, PA, 1999.
[3] Poste L.M., Mackie D.A. Butler G., Larmond E.: Laboratory methods for sensory analysis of food. Canada Communication Group, Ottawa, Canada, 1991, 46-51.
[4] deMan J.M.: Principles of Food Chemistry, 3 rd ed. AsPEN Publishers Maryland, 1999, 183-187.

OCENA TEKSTURY TAJLANDZKIEGO MAKARONU RYŻOWEGO

S t r e s z c z e n i e

Oceniono teksturalne właściwości pięciu tajlandzkich makaronów ryżowych, zawierających zróżnicowaną zawartość mąki tapiokowej (0, 10, 20, 30 i 40%). Podstawą oceny były próby wytrzymałości mechanicznej na rozciąganie i łamanie. Przed pomiarami wytrzymałości na rozciąganie próbkom makaronów nadawano kształt wiosełka. Wykazano, że maksymalna siła, rozciąganie i praca całkowita malały, odpowiednio z 0,55 do 0,43 N, z 82,3 do 59,4 mm i z 0,030 do 0,017 J, w miarę jak zawartość mąki tapiokowej w makaronie wzrastała do 40%. Podobnie, z zawartością mąki tapiokowej pogorszyła się kruchość makaronów. Zaobserwowano wysoką korelację pomiędzy sensoryczną twardością i maksymalną siłą zrywania (r = 0,77) oraz maksymalną siłą kruszącą (r = 0,90).